The Evolution of Throwing: Improving Performance through Kinematic Optimization

The evolution of throwing: Improving performance through kinematic optimization

Neil Thomas Roach, Phillip Roebuck, Daniel E. Lieberman

Abstract:
How do humans throw with such power and accuracy? Chimpanzees, our closest living relatives, occasionally throw using a windmill-type motion, rather than the overarm "baseball" style throw that allows humans to achieve both tremendous power and accuracy. At some point in our evolutionary history, hominins developed the necessary anatomical morphology to produce high performance throws. What these morphological preconditions are, when they appeared, and whether they represent a unique adaptation or are merely exapted, have not previously been investigated. This study experimentally investigates the effects of certain aspects of shoulder and humeral morphology on the kinematics and muscle activation timing necessary to maximize the kinetic energy imparted to a projectile. We collected both three dimensional, whole body kinematics and electromyography data (from the pectoralis major, deltoid, biceps, triceps) from human volunteers. These data are then related to differences in collected performance measures, namely accuracy and velocity. Subjects performed a number of both overarm and windmill style throws, showing statistically different performance output and muscle activation patterns. Preliminary results suggest glenoid orientation and the degree of humeral porsion play important roles in determining optimized throwing kinetics. The implications for understanding early hominin forelimb anatomy and the emergence timing of high performance throwing behavior are addressed.